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ADDITIONAL INVESTIGATION OF THE SOUTH PLUME REMOVAL ACTION WELLS AND THEIR IMPACTS ON THE PRRS GROUNDWATER PLUMES

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FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

September 1991

U.S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS OFFICE

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1.0 Introduction and Scope of Work

The primary objective of the South Plume Removal Action is to protect public health by limiting access to and use of groundwater with uranium concentrations in excess of 30 micrograms per liter (ug/L). Additional objectives are to protect the groundwater environment of the sole source Great Miami Aquifer and control the uranium plume to prevent migration to additional receptors to the south. These objectives were evaluated using the current calibration of the 3-dimensional solute transport model encompassing the South Plume and surrounding areas. This study updates and supersedes work done during the South Plume Engineering Evaluation/Cost Analysis (EE/CA) study (IT, 1990a). Groundwater modeling was performed to assess the effects of moving the removal action wells and of changing their pumping rates. The results of these changes were compared against the removal action objectives to determine their effectiveness in meeting them.

Originally, these objectives were proposed to be met through the installation of four extraction wells which were to pump from the upper portion of the Great Miami Aquifer to extract contaminated groundwater. These wells, termed "interceptor" wells, were to intercept the South Plume by pumping at a rate of 500 gallons per minute (gpm) each, for a total well field pumping rate of 2,000 gpm. The wells were located just to the north of New Haven Road near Route 128 and were evenly spaced a distance of 280 feet apart (IT, 1990a) (Figure 1). At this location and at the proposed pumping rates, the wells were predicted to be able to contain the portion of the southward migrating South Plume above the 30 ug/L contour line (Figure 2). This halted the east-west spread of the plume into further areas and controlled the plume's migration.

Prior to actual implementation of this plan, it was discovered that previously unknown organic and inorganic contaminants were present in the aquifer adjacent to Paddys Run Road. These contaminants were located primarily under property owned by the Ruetgers-Nease Chemical Corporation (Ruetgers-Nease) and the Albright & Wilson (A&W) plant, which collectively are referred to as the Paddys Run Road Site (PRRS) (Figure 1). Contaminants of concern consist primarily of arsenic, iron, and barium around the A&W Plant and volatile organics (ethylbenzene, toluene, xylenes, and isopropylbenzene) around and east of Ruetgers-Nease. Due to the proximity of these contaminants to the proposed interceptor well locations, the capture zone of the well field was examined to determine if the installation and operation of the interceptor wells would impact the organic and inorganic groundwater plumes. Preliminary analysis using analytical data and the calibrated 3-dimensional flow model for the FMPC indicated the wells would capture a portion of the organic plume and most of the inorganics plume. This conclusion prompted a reexamination of the well field location to avoid both of these possibilities.

Discussions held between the Department of Energy (DOE), Westinghouse Environmental Management Company of Ohio (WEMCO), the Ohio Environmental Protection Agency (OEPA), and the U.S. Environmental Protection Agency (U.S. EPA), in May 1991 on this issue prompted a decision to evaluate a new location for the interceptor well field. This new location is to meet as

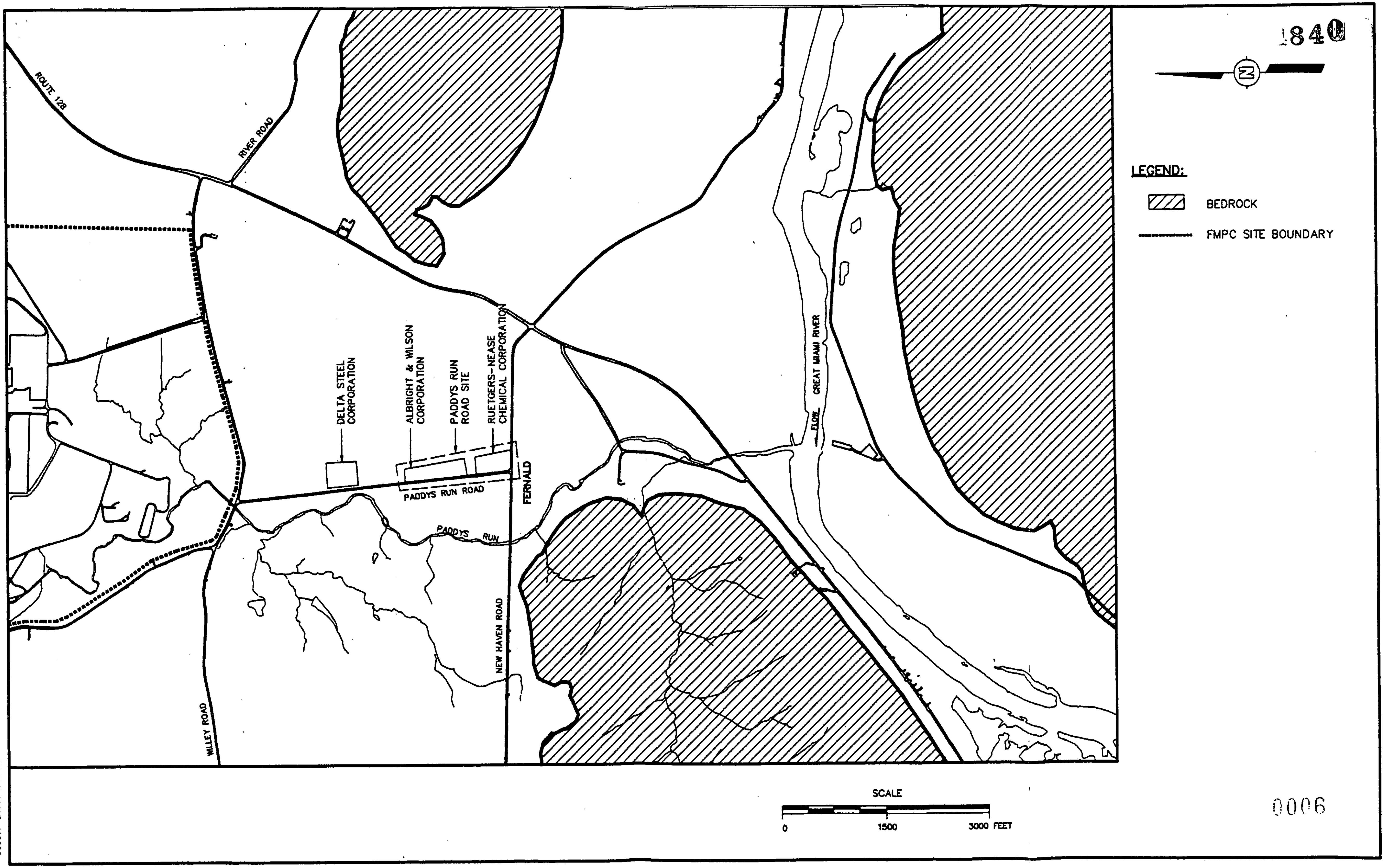

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FIGURE 1
SOUTH PLUME REMOVAL ACTION
REMOVAL ACTION STUDY AREA
AND VICINITY

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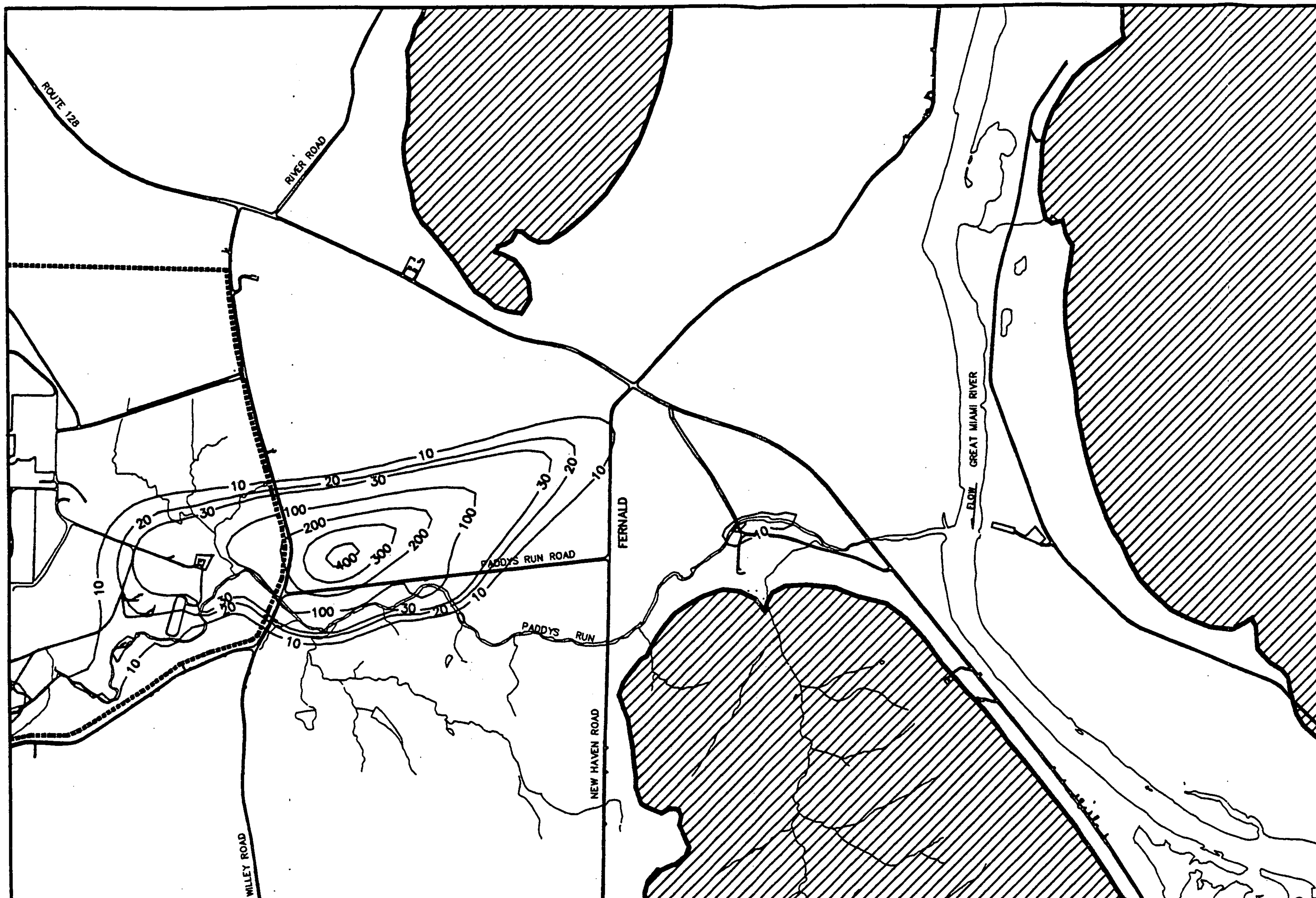

LEGEND:

200 URANIUM CONCENTRATIONS $\mu g/l$. LAYER 1.

BEDROCK

FMPC SITE BOUNDARY

NOTE:

COMPUTER FILE NAME: 3DSOL12-60

SCALE

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FIGURE 2
SOUTH PLUME REMOVAL ACTION
MODELED PRESENT DAY URANIUM CONCENTRATIONS

many of the original objectives as possible while maintaining a capture zone which would neither extract nor create undue influence on the organic and inorganic groundwater plumes. To be evaluated during the modeling study were the possibilities of:

- Reducing the pumping rates of the wells to create a smaller capture zone while maintaining hydraulic control of the South Plume
- Modifying the pumping center of the well field to pump more from the east side of the uranium plume and less from the west
- Moving the well field location north, away from the organic and inorganic groundwater plumes, to avoid capture and limit influence of non-uranium containing groundwater.

This report discusses the investigation undertaken to evaluate a new location for the well field and presents its results.

2.0 Groundwater Modeling Investigation

To evaluate the effects of moving the interceptor wells, the calibrated 3-dimensional solute transport model of the FMPC site was used with a retardation factor of 12. The calibration, verification, and sensitivity analysis of this model is described in previous reports (IT, 1990b). This model was applied using two methods to evaluate the effectiveness and zone of influence of the well field. Particle tracking was first done to determine the capture zone of the well field. This also evaluated the effects of the well field on the organic and inorganic groundwater plumes by tracking particles from wells found to be contaminated by these plumes. Comparisons of particle tracks before and after installation of the interceptor wells allowed the effects of the wells to be quantified. Once a successful capture zone was established, solute transport modeling simulation was done to predict the effects of the well field on the South Plume for a period of five years after its installation. A graphical depiction of the effects of the well field capture of the uranium plume was produced which also determined if hydraulic control of the South Plume was being achieved.

Using these techniques, a series of simulations were conducted to find a new location for the interceptor wells. The various modeling runs are described below.

2.1 Reduced Well Field Pumping Rates

Initial modeling runs were made with the interceptor wells which were left in their previously proposed locations but with reduced pumping rates to minimize the capture of the organics plume located adjacent to Ruetgers-Nease. Several simulations were made during which the pumping rates of all the wells were reduced and during which the western most wells in the field were moved to the east or turned off.

All of these runs proved unsuccessful. Due to the location of the interceptor well field, the pumping was predicted to have significant influence on the contaminant plumes. The inorganics plume and an eastern portion of the organics plume were captured by the wells and the remainder of the organics plume was spread to the east. This resulted in a greater impact to the organic and inorganic plumes due to their spreading and indicated that the interceptor wells must be moved to the north to increase their distance from these plumes.

2.2 Modifying the Pumping Center of the Well Field

The next series of simulations located the wells further to the north and adjusted the rates of the individual interceptor wells to pump more from the east side of the plume and less from the west. The well field remained unchanged from its previous 2,000 gpm pumping rate and 280 feet well spacing. The wells were located in the area east of the A&W plant, along a line proposed by DOE and WEMCO. This alignment ran east from Paddys Run in the area just north of the A&W plant for approximately 750 feet before turning southeast for another 750 feet (Figure 1). This contained the well field within the alluvial terrace within which Paddys Run flows and allowed the wells to remain proximal to the proposed force main. Several simulations were performed in this general area, by varying well pumping rates and shifting the alignment of the well field.

Based on the results of the model simulation, no appropriate location for the interceptor wells could be found in this area. Moving the well field to this location was sufficient to avoid capture or influence of the organics plume but not of the inorganics plume. Simulations of this well field location showed the interceptor wells would either capture a portion of, or greatly spread, the inorganics plume located by A&W. Although changing the pumping center and decreasing the spread of the well field allowed the wells to operate without capture of the inorganics plume, the plume was still pulled to the east and toward the interception wells by up to 250 feet. This caused the areal extent of the plume to spread which was too much influence from the interceptor wells to be an effective location.

Analysis of these simulations also showed that using four wells with a 2,000 gpm well field pumping rate and 280-foot well spacings achieved the best control over the South Plume. This is the same result produced from the earlier South Plume EE/CA (IT, 1990a). Attempts with different well spacings and shifted pumping centers did not significantly change the influence of the well field but did change the capture zone to the extent that the southern migration of the South Plume was not being controlled. Given the high pumping capacity of the aquifer and its thickness in the South Plume area, the previously used well field characteristics of 4 wells at 280 foot spacing, pumping 2,000 gpm, function efficiently.

2.3 Moving the Well Field to the North

The final series of simulations which resulted in the desired performance for the interceptor wells under the new constraints (Section 1.0) were achieved by moving the well field further to the north, adjacent to Delta Steel Corporation's property (Figure 1). The 4-well, 2,000-gpm well field was moved north to pump from an area slightly south of the highest predicted concentrations of the

South Plume. The wells were able to contain the plume and successfully captured contaminated groundwater moving south, away from the FMPC (Figure 3). The portion of the South Plume located south of the well field was not captured by this removal action.

Further analysis of the wells showed them to only have minimal impact on the inorganics groundwater plume located by A&W. Groundwater modeling simulations using particle tracking predicted a maximum plume deflection of 20 feet away from its present path. The predicted effect on the organics groundwater plume located by Ruetgers-Nease was less than 1 foot of deflection. Figure 4 shows the predicted flow paths from wells contaminated by both the organic and inorganic groundwater plumes. These flow paths are shown with the interceptor wells pumping.

Figure 4 also predicts another effect of the interceptor wells, namely the slowing of the velocities of the organic and inorganic groundwater plumes because of the location of the wells to the north of these plumes. The interceptor wells are pumping upgradient of the groundwater plumes. This pumping reduces the groundwater gradient in this area, slowing the movement of the plumes due to the lower groundwater velocities in their vicinity. This results in slowed transport of the organic and inorganic groundwater plumes by one-third.

3.0 Results and Conclusions

Following selection of the interceptor well locations through particle tracking analysis, a solute transport simulation was done to predict pumping effects on the South Plume and the amount of uranium removed from the groundwater. Results of this simulation are shown in Figures 3, 5, 6, and 7. Figure 3 depicts the predicted South Plume configuration after five years of operation of the interceptor wells. During this five year period, the predicted average concentration removed by the well field will decline, as shown in Figure 5. This decline in concentrations results in a declining predicted uranium removal rate, as shown in Figure 6. Declining uranium removal is due to the location of the wells close to the center of the South Plume. Initially, the wells are extracting groundwater with the highest uranium concentrations. As time passes, the uranium plume begins to contract in this area and the highest concentrations of uranium contaminated groundwater are removed. At this point, only the central interceptor wells are extracting uranium at high concentrations because of the narrowing of the plume, resulting in lower removal rates. This decline can also be seen in the predicted cumulative well field removal (Figure 7), which begins to decline after three years of pumping.

The location and completion specifications for the interceptor wells used in the final simulation are shown in Table 1. These specifications are based on optimal efficiency for the well field and do not take into account site features or land ownership issues which might interfere with well placement. For this reason, well placement is flexible and some variation is allowed as is indicated in the footnotes in Table 1.

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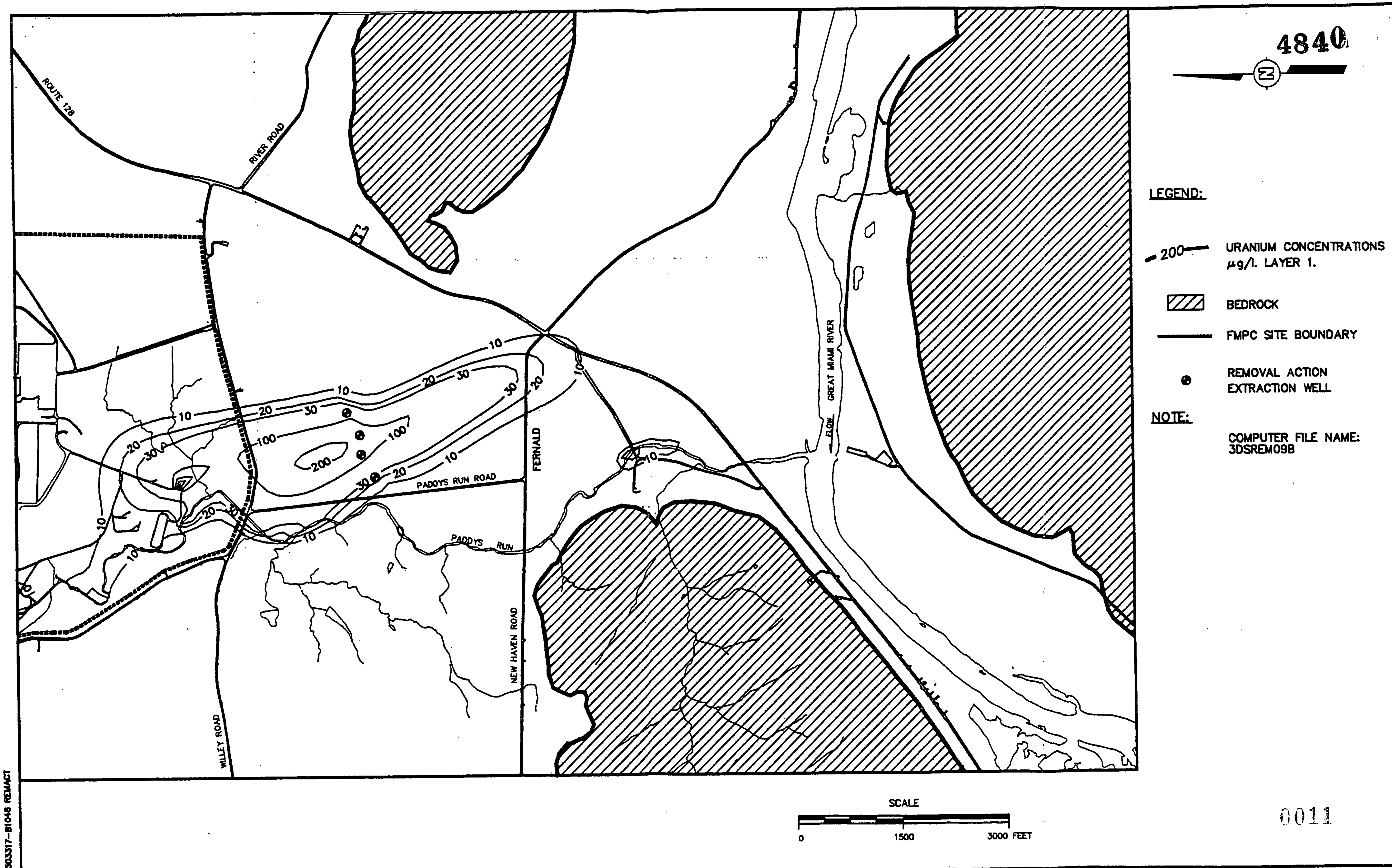

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FIGURE 3
SOUTH PLUME REMOVAL ACTION
PREDICTED EFFECT OF REMOVAL ACTION WELLS
MODELED URANIUM CONCENTRATIONS
5 YEARS IN FUTURE

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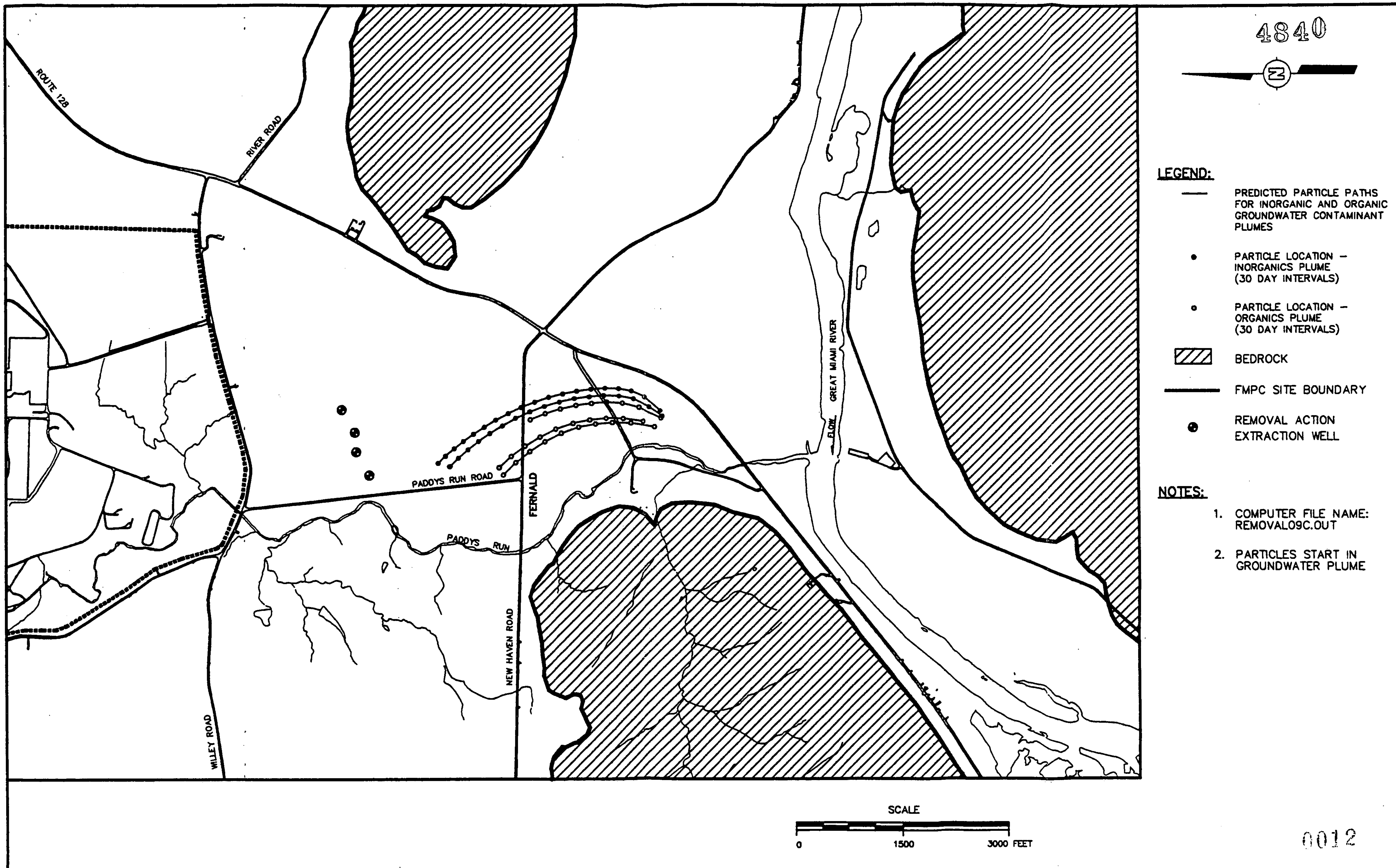

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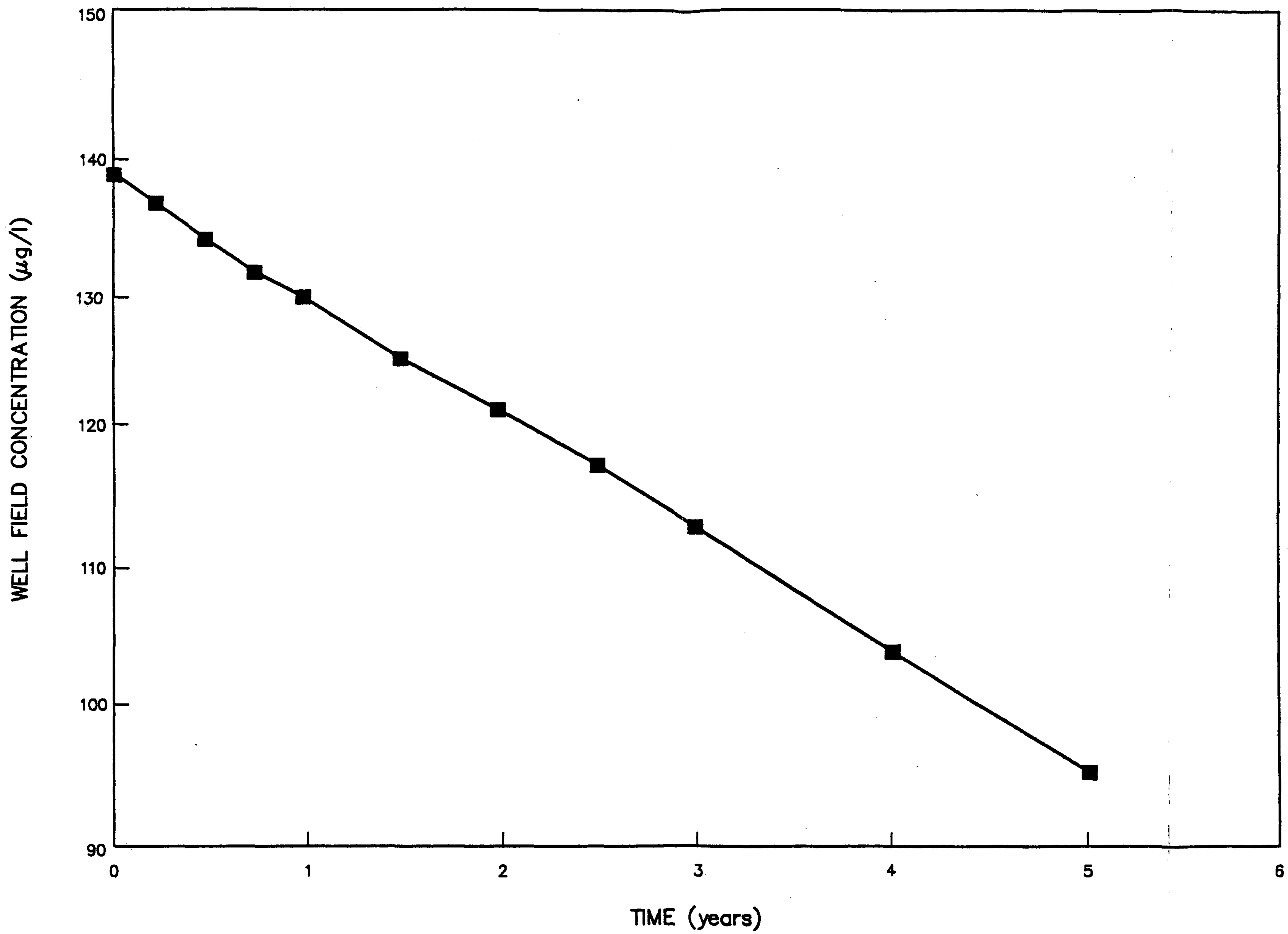
FIGURE 4
SOUTH PLUME REMOVAL ACTION
PREDICTED EFFECT OF REMOVAL
ACTION WELLS ON INORGANIC AND
ORGANIC GROUNDWATER PLUMES



NOTES:
1. TAKEN FROM 3DSREM09E.OUT
2. SEE FIGURE 3 FOR REMOVAL ACTION WELL FIELD LOCATION

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FIGURE 5
SOUTH PLUME REMOVAL ACTION
AVERAGE WELL FIELD CONCENTRATION

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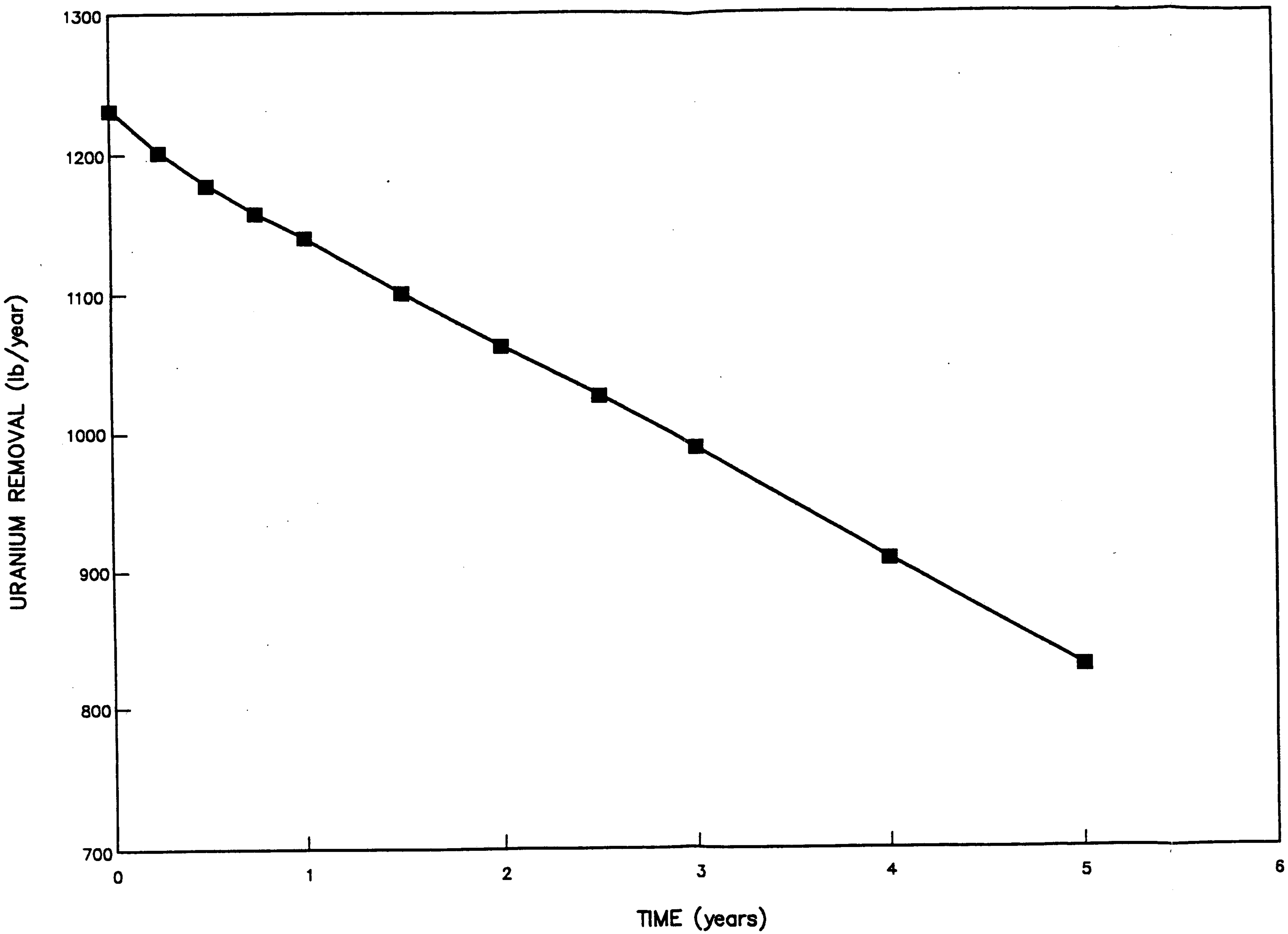

NOTES:

1. TAKEN FROM 3DSREMO9E.OUT
2. SEE FIGURE 3 FOR REMOVAL ACTION WELL FIELD LOCATION

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FIGURE 6
SOUTH PLUME REMOVAL ACTION
WELL FIELD URANIUM REMOVAL RATE

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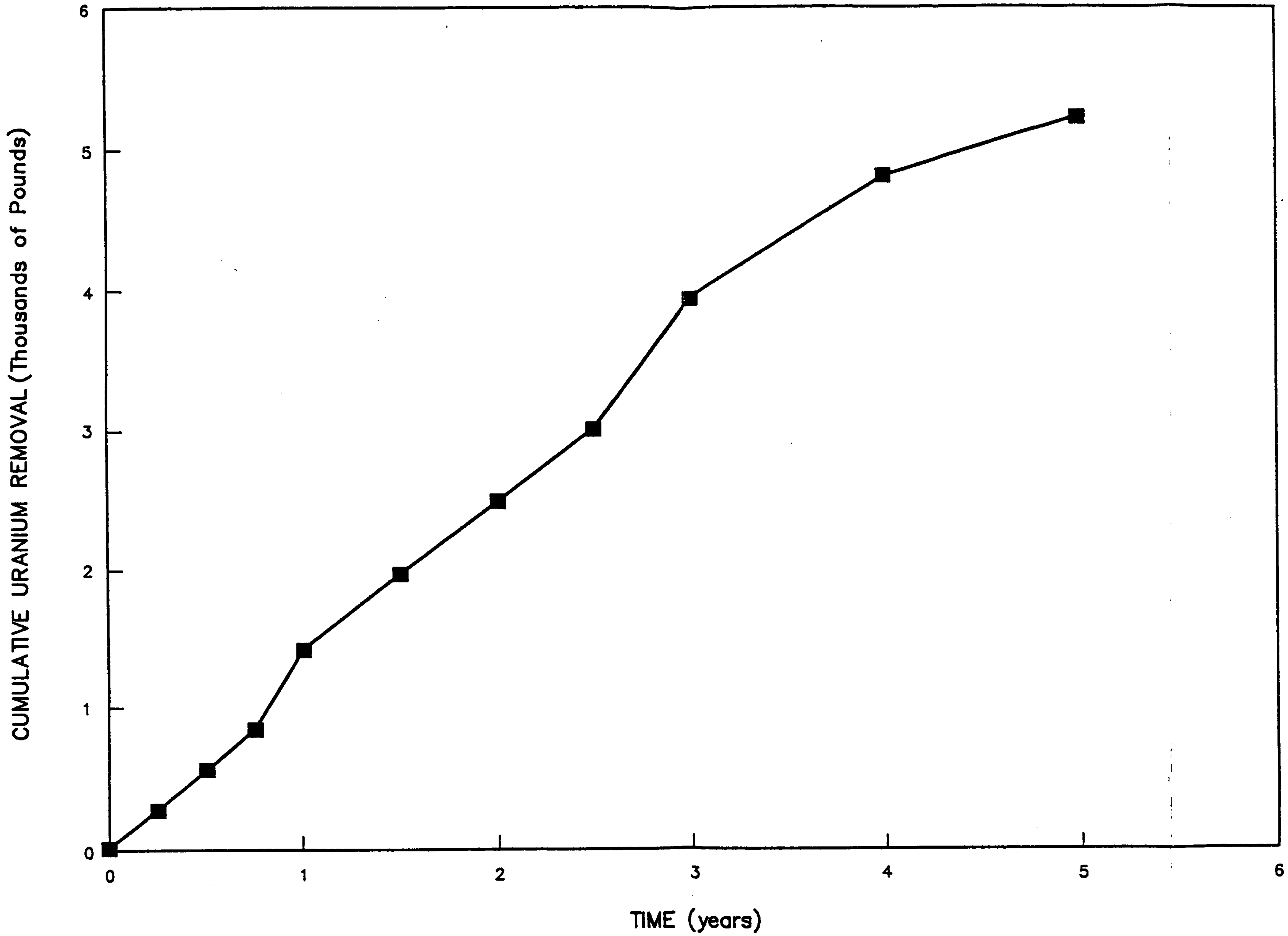

NOTES:

1. TAKEN FROM 3DSREM09E.OUT
2. SEE FIGURE 3 FOR REMOVAL ACTION WELL FIELD LOCATION

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FIGURE 7
SOUTH PLUME REMOVAL ACTION
CUMULATIVE WELL FIELD URANIUM REMOVAL

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TABLE 1

REMOVAL ACTION INTERCEPTOR WELL SPECIFICATIONS

Number of Wells:	4
Pumping Rate:	500 gpm each
Well Diameter:	12-inch-I.D.
Screen Length:	40 feet
Screen Diameter:	12-inch-I.D.
Screen Size:	0.020-inch slots (approximate; determine during drilling)
Screen Placement:	5 feet above static water table to 35 feet below static water table.

Well Locations:

Well	State Coordinates[a] East	State Coordinates[a] North
1	1379841	474259
2	1380165	474448
3	1380444	474466
4	1380768	474654

Well Spacing: 280 feet[b]

[a]Coordinates of wells are ±50 feet any direction.
[b]Well spacing is ±25 feet.

This well design is predicted to contain the 30 ug/L boundary of the plume, while having minimal impact on the organic and inorganic groundwater plumes at the PRRS. It meets the objectives of the removal action, but at the same time, minimizes impacts on other groundwater contaminants. Additionally, it slows the southward migration of the South Plume by further reducing its velocity. The pumping splits the South Plume into two sections: the northern part, of which is a uranium plume; and the southern part, which is a mixed plume of uranium, organic, and inorganic constituents.

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